IN THE SPECIFICATION:

Please amend paragraph number **[0003]** as follows:

**[0003]** State of the Art: The testing of packaged semiconductor devices has always presented problems to device manufacturers. Various types of tests may be conducted at different stages of manufacture. In the current state of the art, "wafer sort" electrical tests may be conducted prior to packaging to determine nonworking dies. Following packaging, various tests including environmental tests as well as parametric and functional electrical tests may be performed. A final test which is known as "burn-in" may optionally be conducted. The test includes temperature cycling over an extended period of time. Essential to the testing of individual dies is reliable electrical connection of all die leads to the test board, without incurring damage to the die or testing apparatus, and easy disassembly from the testing apparatus. While "permanent" wire connections are widely used, wirebonding is time consuming and expensive, and also makes the matching of device impedance to the substrate impedance very difficult to achieve. Much effort is being spent on developing alternative methods to reduce the time and expense of using wire bonds. The replacement of wire bonds with ball grid array (BGA) connections is becoming more common. Temporary conductive attachment of solder balls to ~~e.g.~~ e.g., a test board is less than satisfactory.

Please amend paragraph number **[0004]** as follows:

**[0004]** Temporary connection of device circuits to a test apparatus is known to present a variety of problems. The insert member into which a semiconductor die is placed for testing is typically noncompliant, ~~i.e.~~ i.e., ceramic or silicon, for example.

Please amend paragraph number **[0005]** as follows:

**[0005]** The current method for joining a ball grid array (BGA) to a noncompliant, ~~i.e.~~ i.e., rigid surface such as a silicon micromachined pocket interconnect or insert, is to apply, at ambient temperature, a relatively high compression force of about 22-30 grams-force per solder ball. Theoretically, all balls of the array should be pressed into mechanical and electrical contact

with the insert pocket. The use of compressive forces lower than the above results in a further increased frequency of unsatisfactory electrical connections.

Please amend paragraph number **[0006]** as follows:

**[0006]** The presence of such unconnected solder balls in a BGA attachment formed under ambient conditions is believed to be due to a significant variability in ball diameter and "height" which the industry has been unable to eliminate. As a result, the applied force of about 22-30 grams-force or even more per ball is, in practice, insufficient to ensure the required contact of all balls of the array. Furthermore, the use of compression forces in excess of about 30 ~~grams-force~~ grams-force tends to damage the underlying material of the die, insert, and/or substrate. For example, effective connection of a 48 ball BGA array using solder balls of a nominal diameter may require in excess of about 1.5 kg-force. Such pressures exerted on a die for connection to a ceramic insert may damage the die and/or insert and/or substrate below the insert. The total force required for connection of larger arrays will be even more. In addition, the use of larger balls not only increases the absolute variation in ball diameter but the force required to sufficiently deform each ball for establishing the required temporary electrical connection. The problem also exists with smaller solder balls such as comprise a fine ball-grid-array (FBGA) of 0.0125 inches (0.325 mm) diameter balls, for example. With the smaller diameter solder balls, variation in ball placement location may have a greater effect than nonuniform ball diameters.

Please amend paragraph number **[0009]** as follows:

**[0009]** Semiconductor devices having dual sets of outer "leads," ~~e.g.~~ e.g., twin BGA surfaces or a combination of ~~e.g.~~ e.g., J-leads and solder bumps, are shown in United States Patent 5,648,679 of Chillara et al., United States Patent 5,677,566 of King et al., and United States Patent 5,668,405 of Yamashita.

Please amend paragraph number **[0016]** as follows:

**[0016]** The present invention pertains to methods for electrical contact of an array of solder balls with a noncompliant surface, that is, the mechanical and electrical contact of a ball grid array (BGA) to a relatively noncompliant contact set such as a silicon micromachined pocket interconnect ~~(i.e.~~ (i.e., "insert") for a test pad or burn-in board (BIB).

Please amend paragraph number **[0032]** as follows:

**[0032]** The present invention relates to method and apparatus embodiments for the uniform temporary electrical connection of solder bumps, ~~e.g.~~ e.g., solder balls, of a semiconductor device to another body. Rapid thermal softening of the solder bumps may be achieved by a variety of specific methods and apparatus, as described herein. The methods are particularly useful for attachment of solder bumps to the surface of a noncompliant body such as formed of silicon, ceramic, etc.

Please amend paragraph number **[0034]** as follows:

**[0034]** A test apparatus for evaluating circuit performance of the semiconductor package 10 is shown as including an insert 16 and a substrate member 18. The insert 16 is noncompliant and is typically formed of ceramic or silicon with a pattern of electrical contact sites 20 micromachined on its upper surface 22. The contact sites 20 may comprise simple planar pads, or contact pockets of any configuration, as explained infra. The contact sites 20 are connected by conductive traces, not visible, to bond pads 24, the latter being connected by wire bonds 26 to conductive traces 28 on the substrate member 18. The wire bonds 26 and conductive traces 28 on the insert 16 and substrate member 18 may be encapsulated in resin for protection. Other means for connecting the contact sites 20 to a controller for conducting a test, burn-in, ~~etc.~~ etc., may be used, as known in the art.

Please amend paragraph number **[0035]** as follows:

**[0035]** The substrate member 18 and attached insert 16 are typically inserted into a socket on a test fixture or a ~~burn-in board~~ burn-in board (BIB), neither shown in drawing FIG. 1.

Please amend paragraph number **[0037]** as follows:

**[0037]** In one simple embodiment, an external heater 40 emitting infrared radiation or heated air 42 is positioned to heat the semiconductor package 10 including the solder bumps/balls 12 to the desired softening temperature, and the BGA 30 is quickly inserted and compressed by force 38 into engagement with the contact sites 20 at a relatively low pressure such as about 2-10 g-force per solder bump/ball 12. Referring to drawing FIG. 1A, of course, the required force per solder bump/ball 12 will vary, depending upon the softening characteristics of the particular solder composition used, the temperature to which the solder bumps/balls 12 are heated, the nominal ball diameter 32, the maximum variation in ball diameter 32 and the variation in drop distance 34 between ball centers 34A and the surface 14 of semiconductor package 10. Typically, the required compression force 38 at the softening temperature $T_s$ to achieve complete ball connection is about 8-25 percent of the force at ambient temperature.

Please amend paragraph number **[0039]** as follows:

**[0039]** As shown in drawing FIG. 2, a semiconductor package 10 with an array of solder bumps/balls 12 is placed on an insert 16, and placed under a compression force 38. Thermal energy is applied either to the back side 36 (as shown in FIG. 1) of the semiconductor package 10, to the insert 16, to the substrate member 18 (as shown in FIGS. 4 and 5), to a compression member, not shown, compressing the back side of the semiconductor package 10 with compression force 38, or to a socket, not shown, which surrounds the substrate.

Please amend paragraph number **[0041]** as follows:

**[0041]** Thus, the solder bumps/balls 12 may be heated by conduction, convection or radiation, or any combination thereof. For example, an external heater 40 (FIG. 1) may heat the

semiconductor package 10, insert 16, substrate member 18, or a socket 66 into which the substrate member 18 fits by radiation or heated air 42.

Please amend paragraph number **[0044]** as follows:

**[0044]** A softening temperature $T_s$ of about ~~130~~ 130°C to about ~~180 degrees C.~~ 180°C has been found useful for reducing the compression force 38 to a relatively low value and simultaneously ensuring electrical contact of all solder bumps/balls 12.

Please amend paragraph number **[0045]** as follows:

**[0045]** As shown in drawing FIG. 3, resistive heating elements 44 may be applied to the top surface 48 of the substrate member 18, preferably under the insert 16 and substantially beneath the semiconductor package 10. The heating elements 44 are shown as having heater power leads 54, 56 for providing sufficient power to quickly heat the insert 16 including the electrical contact sites 20, not shown, and the solder bumps/balls 12, not shown, which are in engagement with the contact sites 20.

Please amend paragraph number **[0048]** as follows:

**[0048]** A short heating time is preferred, extending only several seconds or less. Most preferably, the heating time is less than one second. Thus, the heater power leads 54, 56 to the heating elements 44 must be sufficiently large to carry the necessary electrical load. In general, installation of the heating elements 44 on the insert 16 will require separate heater power leads 54, 56. Normally, wire bonds 26 (FIG. 1) are incapable of carrying the necessary load.

Please amend paragraph number **[0049]** as follows:

**[0049]** Another form of heating apparatus which may be used in the invention is illustrated in drawing FIGS. 4 and 5. The substrate member 18 has on its back side (underside) 46, as shown in FIG. 2, a pattern of heating elements 44 with junctions 62, 64. The junctions 62, 64 may be planar pads or conductively surfaced indentations in the back side 46.

Please amend paragraph number **[0051]** as follows:

**[0051]** A pair of through-holes 74, 76 is formed in the test board 70 along axes 84, 86, the axes which pass through junctions 62, 64, respectively. Two metal spring-loaded compression pins 80, also known as "pogo pins," are mounted in the test board 70 or in another substrate 90 underlying the test board 70. Substrate 90, having a plurality of pogo pins 80 projecting therefrom, is known as a bed-of-nails (BON). The pogo pins 80 have a base 78 and a ~~spring-loaded~~ spring-loaded pin 82 which is axially movable relative to the base 78. The spring-loaded pins 82 are shown passing through-holes 74, 76 to electrically contact the junctions 62, 64 when in compression, power leads 92, 94 from the two pogo pins 80 providing sufficient electric power to the heating elements 44 for rapidly heating the solder bumps/balls 12. Following testing, the spring-loaded pogo pins 80 will push the substrate member 18 from the socket 66 with a short stroke.

Please amend paragraph number **[0059]** as follows:

**[0059]** It is clear that a wide variety of apparatus may be used for heating ~~ball-grid-array~~ ball-grid-array connections, of which those described herein are representative.